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# COMPLETE RESEARCH PROGRAM European Corn Borer



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The annual general conference on European Corn Borer Research will not be held during the winter of 1931-1932. This decision has been reached only after a very thorough discussion of the matter with representatives of both Federal and State research organizations and after thorough consideration of the most appropriate and effective utilization of funds now available for European corn borer research. In anticipation of such a decision, the European corn borer research projects of both Federal and State organizations have been reviewed, as to work accomplished during the past year, by the Joint Committee on European Corn Borer Research, and likewise the proposed plans and projects for the coming year have been reviewed and constructively criticized in order that the united program may be in every respect as complete and satisfactory as possible.

The following plans and programs of the Dominion of Canada, United States Department of Agriculture, and the various States have been assembled as the complete program for European corn borer research for 1932. There are also included committee reports as follows:

Joint Report of the Corn Borer Committees of the American Association of Economic Entomologists, American Society of Agronomy, American Society of Agricultural Engineers, American Farm Economic Association, and the American Society of Animal Production.

Report of the Committee on Allocation of European Corn Borer Research.

Additional copies of this program may be obtained from the Bureau of Entomology, United States Department of Agriculture, Washington, D. C.

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# CANADA







EUROPEAN CORN BORER INVESTIGATIONS

GENERAL PLAN AND PROGRAMME

ENTOMOLOGICAL BRANCH, DEPARTMENT OF AGRICULTURE

FOR CANADA

1932-1933

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I. Distribution.

(a) Routine annual scouting to determine new territory infested in Ontario, Quebec and New Brunswick, Nova Scotia, and Prince Edward Island. (In the provinces of Quebec and New Brunswick in co-operation with the local Departments of Agriculture.)

(b) Routine annual scouting to determine status of infestation at selected points in infested territory in Ontario, Quebec, New Brunswick, and Nova Scotia.

(c) The establishment and administration of a quarantine of the infested areas variously restricting the movement of dangerous materials.

(d) The establishment and administration of special restrictions upon seed corn movement.

II. Control.

(a) Further tests of the value of insecticides particularly in regard to the protection of sweet corn.

(b) Study in certain districts in Ontario of the relation between degree of infestation and quality of clean-up.

III. Parasite Control.

(a) Importation, rearing, and distribution of parasites of the corn borer. (In cooperation with the Bureau of Entomology, United States Department of Agriculture.)

(b) Special studies in the biology, technique of rearing and storing in quantity and the distribution of parasites.

(c) Special studies in the establishment of parasites in the field and the recovery of same in nature.

(d) Special studies in the biology of native parasites.

#### IV. Life-history, Seasonal Occurrence and Habits.

(a) Routine annual studies of the field rate of development and life-history in Ontario, New Brunswick, and Nova Scotia.

(b) Winter mortality study in most severely infested area in Ontario.

(c) A study of the mortality of the early instars and the factors controlling same and its bearing upon degree and rate of infestation in Ontario from year to year.

(d) Field and laboratory study of migration of larvae both on and in soil and its bearing upon control.

(e) Distribution of adults in the individual field and in natural harbors.

(f) Flight habits of adults and factors controlling same in the field.

(g) Egg-laying habits of adults and factors controlling the same in the field.

#### EUROPEAN CORN BORER INVESTIGATIONS

#### ONTARIO AGRICULTURAL COLLEGE

#### DEPARTMENT OF ENTOMOLOGY AND ZOOLOGY

##### I - Control.

A- Testing the comparative value of the following methods of dealing with corn remnants in the field:

- 1 - Cutting the stalks level with the ground and cleaning off all remnants and burning them, without plowing.
- 2 - Lifting the stalks up by the roots in the spring so as to leave no borers under ground, then gathering and burning, without plowing.
- 3 - Cutting the stalks low, removing them and then plowing the stubble under completely and gathering and burning any that are dragged up in the spring when cultivating the soil or sowing the next crop.

B- Improving the present farm implements for dealing with corn remnants in the field and devising new and more effective but not costly implements for the same purpose.

- 1 - Determining as definitely as possible the merits and defects of the low-cutting stationary knife for corn binders.



# ENTOMOLOGY







PROPOSED  
PLAN AND PROGRAM  
OF  
EUROPEAN CORN BORER INVESTIGATIONS  
BUREAU OF ENTOMOLOGY  
1932 \*

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Arlington, Massachusetts  
Sandusky, Ohio  
Toledo, Ohio  
Monroe, Michigan  
Hyères, France  
Kobe, Japan

\* Supersedes and supplements "Plan and Program"  
of 1919 - 1931, inclusive

January 1, 1932.

LIST OF PRINCIPAL COOPERATING AGENCIES:

- 1 - U. S. Bureau of Agricultural Engineering.
- 2 - U. S. Bureau of Plant Industry.
- 3 - U. S. Bureau of Chemistry and Soils.
- 4 - U. S. Bureau of Animal Industry.
- 5 - Ohio Agricultural Experiment Station.
- 6 - Illinois State Natural History Survey.
- 7 - Illinois Agricultural Experiment Station.
- 8 - Massachusetts Agricultural Experiment Station.

I - Control.

- A - Burning infested material. (Cooperator 1.)
  - 1 - By machine.
  - 2 - By farm disposal methods.
  - 3 - Laboratory tests: Effect of heat on free larvae and upon larvae encased in cornstalks.
    - a - Tests completed. Analysis of data secured on this project during the period 1928-1930, inclusive.
- B - Feeding infested material to livestock. (Cooperator 1.)
  - 1 - Direct from field; 2 - As silage; 3 - Ground;
  - 4 - From cutting box; 5 - From husker-shredder machines.
    - a - Effectiveness of each method under various conditions of treated material. Also with machines adjusted for various speeds, and length of cut.
- C - Plowing infested material. (Cooperator 1.)
  - 1 - Experimental studies.
    - a - Determination of the influences responsible for migration of larvae to soil surface when plowed under, in the one-generation area.
    - b - Determine duration of period necessary for disintegration of cornstalks when plowed under in soils of various common types. Applies to status of old corn residues as a shelter for migrating borers when again brought to soil surface by plowing, or other cultural practices.
    - c - Check the winter mortality of larvae contained in infested material, plowed under or hand-buried, during the late fall, in the southern portion of the two-generation area. (Berkley, eastern Long Island.)
  - 2 - Field studies.
    - a - Check effectiveness of various plowing methods, by computing percentage of living borers surviving in plant debris, compared to original borer population in stalk and stubble fields.
    - b - Check effectiveness of plowing under early sweet corn in late summer, when stalks are green and succulent.



- D - Varietal and seasonal planting. (Cooperators 1, 2, 5, 6, 7, and 8 - agronomists, corn breeders, and soil specialists.)
- 1 - Experimental studies.
    - a - Planting of commercial standard varieties, hybrids, and strains on sequence of planting dates.
    - b - Corn breeding to determine and to develop plant characteristics tolerant or resistant to severe corn borer injury.
    - c - Special testing of corn for strains resistant or tolerant, or both, to the corn borer.
      - (1) - By manual infestation of series of plots, for each strain, to secure different and progressive borer levels. Data to be taken upon resistance (larval survival), oviposition, plant growth, silking dates, tolerance (yield and stalk breakage), and other significant entomologic and agronomic features.
    - d - Physiological and morphological studies of corn plant, in an attempt to determine the plant influences affecting corn borer resistance and tolerance.
    - e - Determine the damage caused by progressive borer populations to corn planted on different dates, with special relation to testing effect of late planting of corn.
      - (1) - Manually infest 450-plant samples of Clarage corn planted on or about May 5, May 15, May 25, and June 4, for each of three borer levels, approximately 1, 6, and 12 borers, respectively, per plant, on an average.
  - 2 - Field observations.
    - a - Analysis of effect of seasonal planting as revealed by data secured in infestation surveys of commercial fields.
  - 3 - Phenological studies on the development of common trees or shrubs, to correlate plant development with the optimum time of planting corn to avoid severe injury by the insect and with the seasonal occurrence of the insect.
- E - Status of host plants other than corn.
- 1 - Experimental studies in the one-generation area (North Central States).
    - a - Experimental plots of common widely grown field crops, vegetables, flowers, large-stemmed grasses, and weeds recorded as commonly infested by the corn borer in two-generation areas in the United States or in Old World, or in foreign areas of one-generation infestation.
      - (1) - Determine status of each as a true food plant or as a shelter plant, the percentage of plants infested and the larval population.
      - (2) - Study the effect of isolating the corn borer, in cages, on several of the more susceptible plants of the above group, for a period of several years. To determine possible existence of host-plant races, the effect of such isolation upon the insect, and whether such plants will support the corn borer indefinitely in the absence of corn.

2 - Field observations.

- a - Check results secured under I-E-1 with commercial plantings.  
Special stress on such plants when associated with corn, or corn residues, in one-generation areas.

F - Disposal of infested material in barnyard, feedlot, and manure pile.

- 1 - Mortality of larvae or pupae contained in corn residues, or other plant remnants, when incorporated in animal manure.
- 2 - Status of barnyard, feedlot, and manure pile as sources of corn borer infestation.
  - a - Continuation of field observations to check results secured in experimental studies.

G - Insecticides. (Cooperators 1 and 3; State workers; Dominion of Canada; and Province of Ontario.)

1 - Laboratory investigations.

- a - Chemical tests - exact formulae of materials, deterioration in storage and on host plant, residues, retention of lethal capacity and toxicity to livestock, compatible combinations, value of emulsifying agents, cause of intolerance.
- b - Biological tests - ovicidal value (specific effects, time and quantity required), larvicidal capacity.
- c - Relation of insecticides to feeding habits - distribution of insecticide, distribution of feeding punctures, materials ingested, materials rejected, nature of tropic-response complex governing feeding and tunnelling reaction.

2 - Experimental tests.

- a - Materials - arsenicals, emulsified extracts and water solutions, oil emulsions, fluorides, derrisol, nicotines, plus new insecticides from U. S. Bureau of Chemistry and Soils, or other sources, involving carriers, emulsifiers, adhesives, etc.
- b - Tests in replicate with alternate checks, in small and in commercial plots, to determine toxicity, adhesiveness, plant tolerance, number of applications, cost of application for small areas and for large-scale operations.
  - (1) - As liquids or as dusts.

3 - Trial field tests.

- a - Efficiency with respect to toxicity, plant tolerance, and cost of application.

4 - Commercial field tests.

- a - Efficiency and cost of method and material.
- b - Profit under commercial conditions.

5 - Detailed study of response of adult, relating to insecticide applications. (See II-C-2.)

6 - Collaborative insecticide program with interested State workers.

H - Storage of cornstalks. (Cooperator 1.)

- 1 - Experimental studies.



- a - Studies upon comparative survival to adult stage of larvae contained in cornstalks stored under diverse conditions of moisture and temperature exposure, on progressive dates during late fall, winter, and spring. Determine percentage of original borer population surviving to adult stage.
- 2 - Field observations. Check experimental results by examination of corn or corn residues, stored under typical or special farm conditions.
- 3 - Percentage of survival to adult stage in baled cornstalks.
  - a - Under diverse conditions of moisture and temperature exposure.
  - b - When cornstalks are subjected to different processing before baling, such as cutting or shredding.
  - c - When cornstalk material is subjected to diverse baling pressures.
- I - Trap crops.
  - 1 - Field observations in the one-generation area (North Central States).
    - a - Check results of trap crop plantings, where a sequence of corn planting occurs on same or adjacent farms from early season to late season. Analyze results of annual infestation survey and experimental plot data on same basis.
- J - Miscellaneous control projects. (Cooperators 1, 2, 3, 5, 6, and 7.)
  - 1 - Tests to determine relation of moisture content of infested ear corn, at time of heat treatment, to subsequent viability of seed corn, and rate of borer mortality.
  - 2 - Demonstrations of the comparative efficiency of common or recommended farm corn borer control or farm disposal practices. Staged under screened enclosures approximately 1/10 acre in size.
    - a - Simulate farm practices to demonstrate relative percentage of survival to adult stage when --
      - (1) - Entire stalks are cleanly plowed under, followed by disk harrowing.
      - (2) - Same as preceding, followed by spring-tooth harrowing.
      - (3) - Stalks are cut at ground level, and removed from field, followed by disk harrowing.
      - (4) - Six-inch stubble disked.
      - (5) - Entire stalks disked.
        - (aa) - In each screened enclosure, the larval population is determined before treatment, cage erected just prior to adult emergence, cage dismantled at end of moth flight period. Resultant borer population in each test area is determined at harvest period. Comparisons are made between test areas, and with unscreened adjacent check areas. Com-

parative data are taken upon crop yields, plant development and meteorological phenomena, inside cage and in unscreened adjacent check areas.

- 3 - Crop residue treatments, in relation to corn borer control.  
(Under supervision of Cooperator 1.)
  - a - Soil conditions, or tilth, in relation to clean-up or farm disposal of infested corn residues.
    - (1) - Effect of various farm machinery methods of treating entire cornstalks or stubble.
- 4 - Coverage and draft tests, in relation to corn borer control.  
(Under supervision of Cooperator 1.)
  - a - Same as I-J-3-a.
    - (1) - Effect of various crop rotations and cover crops.

## II - Seasonal Occurrence and Habits.

### A - Seasonal occurrence.

- 1 - One-generation area.
  - a - Systematic dissections of infested cornstalks, under various typical habitat conditions.
  - b - Progress of egg deposition in the field, as a guide to other field projects.
  - c - Field dissections and observations in late summer and early autumn to determine possible development of second-generation individuals.
  - d - Phenological studies as detailed under I-D-3.
- 2 - Two-generation area.
  - a - Same as II-A-1-a.
  - b - Determine percentage of individuals developing a second generation
  - c - Determine causes of variation in seasonal development.
  - d - Determine districts of separation, or possibly intermingling, between one-generation and two-generation "strains" in those portions of infested areas where the two "strains" are occupying the same or adjacent territory.
  - e - Determine limits of the two-generation area in the United States, as indicated by summer pupation or other reliable features.
- 3 - Special studies to determine influences contributing to the separation of the one-generation and two-generation cycle zones.
  - a - In the United States, Europe, and in the Orient.
    - (1) - Biological, meteorological, ecological.

### B - Habits of larvae.

- 1 - Migration.
- 2 - Hibernation.
  - a - Records of winter mortality in the field, under various conditions of exposure. Taken incidentally during progress of other work.



3 - Mortality.

- a - Records of larval, prepupal and pupal mortality during period of high temperature and desiccating winds.
- b - During establishment, or growth from egg to mature larva.  
(Survival. Also see experiments.)
  - (1) - In experimental plots (See I-D and VI-B).
  - (2) - In large cornfields under typical field conditions.
  - (3) - Special study of the causes influencing the progressive disappearance of borers from standing cornstalks, beginning with the period of maximum abundance in August, to late in the spring.
  - (4) - Special study of the mortality of the larvae from hatching to maturity, in connection with determination of damage to corn per borer.
- (aa) - Manually infest 50-plant samples of Clarage corn on July 6, for dissections at weekly intervals from July 13 to August 31, to determine relative population on each date.

4 - Food and feeding habits.

- a - Special study of feeding responses of first-instar larvae.
- b - General studies upon choice of food and feeding habits.

C - Habits of adults.

1 - Oviposition.

- a - Selection of plant species or variety, stage of plant development, and parts of plant.
- b - Meteorological and seasonal conditions affecting oviposition.

2 - Flight. Special field studies at Berkley, Toledo, and Monroe, with special reference to practical application to insecticide and bait-trap investigations.

- a - Influence of air conditions on the manner and extent of flight.
  - (1) - Effect of visibility, wind direction and velocity, relative humidity, temperature, evaporation rate and barometric pressure, on the extent, elevation and duration of flight.
- b - Relation of flight to emergence and oviposition.
- c - Relation of flight to the topographic situation of cornfields and weed areas.

3 - Response phenomena in adult (Arlington).

- a - Separation and identification of response phenomena.
  - (1) - Feeding; flight; mating; oviposition; chemotropic.
- b - Influence of tropic-response phenomena upon chemotropism.
  - (1) - Development of chemotropic threshold.
  - (2) - Sequence of reactions initiating a chemotropic response.
- c - Special flight field study - (Arlington, Toledo, Monroe).
  - (1) - Influence of air conditions on the manner and extent of flight.
    - (aa) - Effect of visibility, wind direction and velocity, relative humidity, temperature, evaporation rate and barometric pressure, on the extent, elevation and duration of flight.

- (2) - Relation of flight to emergence and oviposition.
- (3) - Relation of flight to the topographic situation of cornfields and weed areas.
- 4 - Response to odors in olfactometer (Arlington).
- 5 - Effectiveness of bait-traps (Berkley, Toledo).
  - a - Comparative effectiveness of selected attractants.
  - b - Comparative effectiveness of trap construction.
  - c - Preparation of baits.
  - d - Operation of bait traps.
- (1) - Practical applications. (Insecticide applications, scouting, etc.)

### III - Host Plants.

- A - Incidental continuation of complete host-plant lists and classification according to degree of susceptibility and status as a food plant or as a shelter plant.
- B - Incidental continuation of investigations relative to stages of P. nubilalis occurring on listed host plants. Special reference to plants or portions of plants likely to enter commerce.
  - 1 - Condition of plant as affecting food value or toxicity.
- C - Isolation cages in one-generation area, containing susceptible host plants other than corn. (Procedure and objectives same as detailed under I-E-1.)
- D - Study of host plant communities, both natural and artificial, in respect to choice of host by the adult and larva. (Two-generation area..)

### IV - Dispersion.

- A - Flight - refer to II-C-2.
- B - Relation of common carrier to dispersion.
  - 1 - Continuation of investigation relative to transportation of all stages of P. nubilalis in commercial products.
- C - Relation of water-drift to dispersion of infested host plants or waste commercial residues.

### V - Population Investigations.

- A - The surveying of corn borer populations.
  - 1 - Large-scale surveys, or area-wide surveys. To supply seasonal information upon the fluctuation of borer populations. (Cooperator 5.)
    - a - Debris survey.
    - b - Egg survey.
    - c - Standing plant survey. (Infestation survey.)
  - 2 - Special sweet-corn surveys. (One-generation and two-generation areas.)



- a - Borer population at harvest.
- b - Percentage of unmarketable ears.
- c - Survey of canning industry to estimate losses incurred by canners and contract farmers.
- 3 - Vegetable surveys. (Two-generation area.) To supply specific information upon infestation in important vegetable crops.
- 4 - Special surveys.
  - a - District surveys in two-generation and one-generation areas of Long Island.
  - b - Complete series of observations at the Berkley, Mass., farm, as a complement to the experimental work at that point.
  - c - Surveys of important host-plant habitats in the two-generation area, either by some modification of a "strip" survey system or special study area.
  - d - Cooperative surveys with parasite projects, to directly associate parasite population with host population, and to supply similar mutually useful information. Applies to area-wide surveys and to surveys in vicinity of parasite colony sites.
- B - The determination of the more important factors which maintain different levels of borer population.
  - 1 - Climate type.
    - a - Normal characteristics for important economic areas which correspond with varying densities of population.
    - b - Variation of significant factors from the normal, and the probable occurrence of highly favorable or unfavorable combinations which produce distinct fluctuations in corn borer population.
  - 2 - Plant habitat.
    - a - Host concentration, dominance and type, in various habitats.
      - (1) - Particular attention devoted to charting of habitats in two-generation area, where diversity of host plants has a tendency to maintain higher corn borer populations than in habitats where one generation occurs.
      - (2) - Studies of relationships between densities of population and the varying economic uses of the host plant, as applied to conditions in the North Central States.
  - 3 - Agricultural practice.
    - a - Particular attention devoted to the effect of leaving or removing from habitats the residues of economic hosts.
    - b - Also, to the concentration of residues of noneconomic hosts in the two-generation area.
- C - The classification of corn borer habitats according to seasonal development features and level of population, with the objective of charting the important economic centers of infestation.
  - 1 - In all distinct environments, throughout the distribution of P. nubilalis, the variations in abundance and bionomics

will be brought to the basis of a normal. The probable occurrence of variations from this normal will be determined.

- a - Life history and seasonal history.
  - (1) - Particular emphasis directed to the study of intermixture of one-generation and two-generation "strains."
  - (2) - Normal and deviations from normal, as associated with significant factors in the environment.
- b - Population fluctuations.
  - (1) - Normal levels of population as associated with significant factors in the environment and their relation to probable damage.
  - (2) - Probable occurrence of sharp deviations from the normal level of population and their environmental and economic significance. The economic aspect of deviation from the normal corn borer population level will be studied.
- 2 - The areas of different levels of population defined, for the purpose of indicating chronic sources of corn borer abundance as a guide to crop culture and control.
  - a - Regions where outbreaks are of frequent occurrence.
  - b - Regions where the borer population is frequently dangerous, but where distinct outbreaks seldom occur.
  - c - Regions where the borer population is only occasionally of economic significance.
- D - The determination of the effectiveness of control measures, natural or artificial, in reducing corn borer populations under area-wide conditions.
  - 1 - Weather. 2 - Vigor of corn plant. 3 - Varieties of corn. 4 - Agricultural practice. 5 - Parasites. 6 - Insecticides, etc.
- E - Biometrical studies, with the objective of improving methods of estimating corn borer abundance, and analyses of population data.
  - 1 - Survey methods (sampling methods).
  - 2 - Investigation of plot technique which may affect the interpretations of the relation between corn borer abundance and influences effecting changes therein.
  - 3 - The securing of a generalized damage index which may be applicable to field data; i. e., translating borer population into terms of economic loss, as affected by varying effects of soil and climatic conditions, time of planting, variety and type of corn, etc.
- F - Coordination of abundance data from projects which, although technical studies in themselves, offer fundamental data useful for interpreting the economic status of the corn borer populations.
  - 1 - Larval survival.
  - 2 - Varietal tests.
  - 3 - Damage investigations.
  - 4 - Artificial control.



- G - The economic aspect of corn borer populations.
  - 1 - Analyses of population surveys to compute probable economic losses involved in representative agricultural regions.  
(See V-E-3.)
  - 2 - The relation between the value of the crop, the loss sustained by corn borer populations, and the amount of funds that could justifiably be expended upon control measures.
- H - The preparation of reports upon the status of the corn borer, with suitable interpretations of the effect of seasonal conditions upon corn borer abundance.

## VI - Damage and Commercial Loss.

Note: Data for analyses under this section will be obtained from "Damage Projects" conducted at Sandusky, Toledo, and Arlington.

- A - Analyses of population surveys to estimate probable economic losses involved in representative agricultural regions.
- B - Special study of resulting economic damage to corn by various progressive levels of manually induced borer population.  
(Cooperators 1, 2, 4, 5, 6, 7, and 8.)
  - 1 - In five different soil types, secure weights of stalks and ears of 400-plant samples of a uniform strain of Clarage corn, each sample containing, on an average, 1, 5, and 10 borers, respectively, per plant.
    - a - At Sandusky, Ohio, on very fine sandy soil.
    - b - At Toledo (Maumee) Farm, on very fine sandy loam.
    - c - At Toledo (Maumee) Farm, on a soil containing a quantity of clay.
    - d - At a location about 2 miles southwest of the Toledo (Maumee) Farm, on a soil considered poor for corn production.
    - e - At the Holgate Farm of the Ohio Agricultural Experiment Station, on a soil sufficiently rich to produce a yield of approximately 100 bushels of corn per acre.
  - 2 - In one soil type, and at one level of soil productivity (i.e., one field of uniform soil at the Toledo (Maumee) Farm), determine the relative yields from five widely diverse and representative varieties of commercially planted corn, subjected to various progressive levels of manually induced infestation (5, 10, 15, 20, and 30 borers, respectively, per plant, on an average). Each variety to be replicated, and each replicate accompanied by a check which is subjected to natural infestation only. All varieties to be planted on the same date, under uniform soil conditions, and to receive similar cultural treatments.
    - a - Three varieties of dent field corn (small, medium, and large types), and two varieties of sweet corn (mid-season and late-season types).

- b - Adequate samples taken from each borer level in each variety and in each replicate, and from each check, to determine borer population, and the relative losses in weight, quality, and total nutrients of ears, grain, stalks, leaves and husks, chargeable to P. nubilalis. The entire plot, with the exception of border rows, will be harvested to secure yield data.
- 3 - Duplication of VI-B-2 under two-generation conditions of New England, employing commercially grown sweet corn varieties only, with early and late season plantings to correspond with commercial sweet corn practices, and to observe effects of the first generation and second generation of the borer.
  - a - Objectives, plot technique, sampling methods and analyses of data are substantially the same as for VI-B-2.
- 4 - Tolerance tests of four special corn varieties or hybrids, which have indicated a high degree of tolerance to corn borer damage in small experimental plot tests.
  - a - Objectives, plot technique, sampling methods, and analyses of data are substantially the same as for VI-B-2 (5, 15, and 30 borers, respectively, per plant, on an average).

#### VII - Investigations in Europe.

- A - Seasonal occurrence.
  - 1 - Collection of data to determine transition zones between areas of one and two generation seasonal occurrence.
    - a - Data will be collected in the transition zones for the purpose of studying meteorological conditions in connection with seasonal history and number of generations.
- B - Abundance and damage.
  - 1 - Continuation of surveys in the Danube Basin and in Italy and France to determine larval population, larval survival in connection with agricultural practices, and extent of corn borer injury.
- C - See section upon parasite and predator investigations in Europe (IX-B).

#### VIII - Investigations in the Orient.

- A - Continued studies on distribution, seasonal history, host plants, abundance and damage, principally incidental to parasite investigations.
- B - See section upon parasite investigations in the Orient (IX-C).

#### IX - Natural Enemies.

- A - Parasites (Investigations in United States).



1 - Foreign parasites.

- a - Importation of desirable species from Europe and the Orient.
- b - Liberation of all parasite adults not required for laboratory breeding, or biological studies, at selected points in areas infested by P. nubilalis. Special stress upon precautions to prevent escape of hyperparasites.
- c - Allotment of quota of imported parasite material to two-generation area (New England), one-generation area (North Central States), and to cooperators in Canada.
- d - Breeding and liberation of each parasite species for which a satisfactory breeding technique has been developed.
- e - Investigations to develop, or perfect, the breeding technique for each promising parasite species not yet satisfactorily solved, through a critical, practical study of their biology.
- f - Perfection and improvement of existing rearing and breeding methods, to increase efficiency and economy.
- g - Field collections, to attempt the recovery of imported parasite species, with special reference to direction and velocity of dispersion, and percentage of host parasitized, furnishing host abundance figures when possible.
  - (1) - At selected points in infested districts.
  - (2) - From parasite conservation cages (limited).
  - (3) - Includes collections of P. nubilalis and associated species.
- h - Morphological and life-history studies, seasonal occurrence, habits, host relationship, and other important biological reactions of certain of the imported species.
- i - Investigations to determine the reaction of imported parasites, particularly their survival, to common control or farm disposal practices directed against P. nubilalis. (Stressed.)
- j - Preparation of imported parasites and hyperparasites for taxonomic study and exhibit.

2 - Native parasites.

- a - Observations and systematic collections of P. nubilalis for rearing at selected points, and from parasite conservation cages.
- b - Taxonomic and morphological studies of reared native parasite material.
  - (1) - Systematic grouping of reared individuals.
  - (2) - Study of morphological characters to aid in their identification and separation from imported species. Involves a photographic study.
  - (3) - Preparation of material for reference to group specialists.
- c - Studies upon the economic status and abundance of native parasites recovered from parasite conservation cages, with due allowance to their assignment to the proper

host, as well as by isolated, individual rearings.  
Special attention to the comparative status of each  
native species from year to year, as a natural enemy  
of P. nubilalis.

- d - Studies of native or imported parasites attacking host  
species associated with P. nubilalis, which are, or may  
later become, parasitic upon P. nubilalis.

B - Parasites and predators (Investigations in Europe).

- 1 - Continuation of large-scale shipments of parasites to  
America. Following species will be shipped:

<u>Lydella senilis</u>	<u>Microgaster tibialis</u>
<u>Zenillia roseanae</u>	<u>Apanteles thompsoni</u>
<u>Zenillia mitis</u>	<u>Macrocentrus gifuensis</u>
<u>Linnerium alkae</u>	<u>Phaeogenes nigridens</u>
<u>Angitia punctoria</u>	<u>Eulophus viridulus</u>
<u>Chelonus annulipes</u>	<u>Camponex pyraustae</u> ( <u>lugubrinus</u> )
	<u>Camponex multicinctus</u>

- 2 - Further efforts will be made to find Pristomerus vulnerator,  
not yet imported to America.
- 3 - Continuation of studies on cold storage and packing tech-  
nique, in relation to shipping of cocoons and parasitized  
larvae.
- 4 - Study of parasite population and value of parasites as con-  
trolling factors of P. nubilalis in the different faunal  
zones of Europe.
- 5 - Studies upon the biology and morphology of Itopectis  
ephippium.

C - Parasites (investigations in the Orient).

- 1 - Large-scale shipment of larval parasites to America.  
Principally from eastern Manchuria, Kyshu Island (Japan),  
and northern Chosen (Korea).
  - a - Cremastus hymeniae (special stress)
  - b - Bracon atricornis
  - c - Inareolata punctoria
  - d - Macrocentrus gifuensis
  - e - Ceromasia lepidia
  - f - Eulimneria crassifemur
  - g - Microgaster tibialis
- 2 - Pupal parasite study - trial shipments from Chosen (Korea)  
and Japan.
- 3 - Egg parasite study - possibly trial shipment.
- 4 - Special surveys on Shikoku Island.
- 5 - Maintenance of relations with workers in Taiwan (Formosa)  
and Loo Choo (Ryu Kyu) Islands.



D - Predators.

- 1 - Insects, spiders, birds, rodents, skunks, etc.
  - a - Investigations relating to the economic status of the above.
  - b - Europe - Studies of lacewing flies as predators of P. nubilalis eggs.
  - c - Orient - Mermithids attacking P. nubilalis larvae.

E - Disease.

- 1 - General observations upon mortality of P. nubilalis larvae, attributable to disease, or disease-producing organisms, in the field or in rearing cages.
- 2 - Beauveria bassiana.
  - a - Laboratory tests.
  - b - Mycological studies.
  - c - Field tests (dust or water carriers).
    - (1) - Establishment of overwintering generation and of summer generation.
    - (2) - Dispersion.
  - d - Large-scale operation and technique, if justified by developments.
- 3 - Orient - Special attention to diseases found in Manchuria and Chosen (Korea).

X - Miscellaneous.

- A - Collection and preservation of all stages of P. nubilalis and associated insects, together with typical samples of injury to host plants, and all parasites, for study and exhibition purposes.
- B - Studies of biology, morphology, distribution, and economic importance of insects frequently confused with, or associated with, P. nubilalis. Includes a complete investigation of natural enemies of such species.
- C - Continuation of complete photographic preparation of all phases connected with biology of P. nubilalis and closely associated insects, natural enemies, control equipment, and methods of disposing of infested material. Special stress upon photos for exhibition and manuscript purposes.





# BUREAU OF AGRICULTURAL ECONOMICS







## STUDIES RELATING TO THE CORN BORER

By the Bureau of Agricultural Economics

1. The analysis of types of farming in the States of the corn borer region will be continued in 1931-32. Studies of this nature have been completed in Indiana, Michigan, Minnesota, Missouri, South Dakota, and North Dakota. Similar studies are under way for Kentucky and Wisconsin, while studies of this nature are proposed for Illinois and Pennsylvania. A similar but independent study was made by the Agricultural Experiment Station at Ames, Iowa.

Areas with similar systems of farming are outlined in these studies. The importance of corn on these farms is shown, using various criteria. The factors related to the importance of corn are especially considered. This is significant in areas where the proportion of corn in the farm organization may be subject to modification following upon the introduction of a control program developed to combat an invasion of the corn borer. The basic material and comprehensive view of the local farming derived from these farming type studies in the Corn Belt States are being used as a basis for formulating farm management studies of a different and more intensive type. These more intensive studies relate to the adjustment in farm organization and farm operation made necessary or impending as a result of the corn borer.

2. The study of farm organization and operation in an important corn growing region in Indiana has been continued through 1931. This region is contiguous to the existing region of infestation. Here 75 per cent of the corn crop is husked from the standing stalks. This is important in a consideration of corn borer control. This is also an area in which winter wheat is an important crop. Of the wheat grown in 1929 and 1930, 56 per cent was seeded following corn, 35 per cent being drilled into standing corn while 21 per cent was seeded on land from which the corn had been cut. Oats are also important in this region, about 86 per cent of the oats acreage being seeded upon corn ground without plowing. The large fraction of the oats acreage seeded without plowing and the large proportion of wheat seeded in standing corn will have an important bearing on corn borer control programs. These instances represent the type of information which, with data on the duty per man per unit of power and per machine, represents the basis for study and experimentation on revised crop rotations and revised operations in the production of the maximum volume of corn consistent with all the conditions involved. Work on this project will be continued in 1932.

The similar study in southeastern Michigan in a region already infested with the corn borer is furnishing data of a like nature. In addition, significant information is being gained on the





efforts of farmers to adjust themselves to the conditions incident to infestation, and the effect upon other enterprises, particularly in terms of the utilization of labor, power, and materials. These data should be of considerable value in assisting further in planning effective farm organizations and farm reorganizations in this and other areas. This project likewise will be carried forward in 1932.

A study in northwestern Missouri, based upon lines similar to the studies in Indiana and Michigan, was instituted in the autumn of 1930. It is planned to gain for this area significant information relative to the production of corn and the other crops in this physical and economic setting. The data, secured well in advance of the possible infestation of this area, should provide valuable information relative to the changes likely to be in order when danger of infestation becomes more real. This study also will be carried on in 1932.

All these studies are being conducted in cooperation with the State Experiment Stations.

3. In connection with the projects listed under "2", especial attention is being given to the newer forms of equipment, as corn picker harvesters, grain harvester combines, new power units, etc., in their use under actual farming conditions. This is essential, since corn borer control programs may involve the further utilization of such items of equipment; as, for example, those which will facilitate speedier harvesting of corn in the autumn, thus permitting autumn plowing, whether for wheat or oats or replanting to corn. The harvesting of substitute crops, as soybeans, with a combine harvester is also an important development, as well as the further use of such means of harvesting and utilizing corn as the field silage harvester.

4. The study made to determine the conditions under which it will be advantageous for farmers to substitute other crops for all or a part of their corn acreage has been completed and transmitted to the editors for publication. In this connection the following factors were considered: (1) Possible damage by the borer and reduction in the yield of corn; (2) increased labor and power required for growing corn under corn borer conditions; (3) possible reduction in yields of other crops because of delayed seeding or changes in methods of preparing the land; and (4) relative returns for corn and other crops. This included a study of the outlook for such crops as sugar beets, canning crops, soybeans, alfalfa, and other feed crops, and the way in which these would fit into present cropping systems. The experience of farmers in Ontario, Canada, in increasing the acreage of tobacco, sugar beets, and canning crops, due to the reduced corn acreage on account of the corn borer, was considered in connection with this study. The results led to the conclusion that, for the major portion of the Corn Belt, corn would remain as a primary crop with the addition of a control program.

5. Another study dealing with the economic phases of harvesting corn has been completed in cooperation with the Illinois Experiment Station. In this study were treated not only husking corn by means of hand methods and the newer forms of the mechanical picker but also the making of silage, both with the older

forms of stationary cutters and the newer field silage harvester. Information gained in this study should prove of value to producers of corn in adjusting themselves and their farm organizations to changes forced upon them due to invasions of the corn borer.

# BUREAU of AGRICULTURAL ENGINEERING







## CORN BORER CONTROL PROGRAM FOR THE FISCAL YEAR 1932

Division of Mechanical Equipment,  
Bureau of Agricultural Engineering

Cooperation will be given in both the Eastern and Western areas of infestation with the Bureau of Entomology and the Plant Quarantine & Control Administration in all control projects involving the use, adaptation, and development of farm and other machinery and attachments.

- I. Soil working. (To include horse plows as far as is practicable.)
  - A. Continuation of studies on trash coverage as affected by:
    - a. Different types of plow-bottoms - determining the proper type for each general soil or section of the corn raising States.
    - b. Speed of plowing.
    - c. Plow width - and width selection for different soil types.
    - d. Plow depth - and plow depth-width relation for optimum performance.
    - e. Attachments - special attention being paid to the development of devices for effecting good coverage.
  - B. Continuation of studies on the draft of plows as affected by plow-bottom shape and size and depth of plowing, by soil type and condition, and by speed of plowing.
  - C. Studies to determine the best use of machines now in the farmers' hands; and, if possible, formulate recommendations whereby a farmer can make effective use of his present equipment.
  - D. Cooperative studies as far as practicable according to A, B, and C.
    - a. Continuation of work with Illinois.
    - b. Continuation of work with Pennsylvania.
    - c. Continuation of work with the New England States.
    - d. Initiation of work with New Jersey.
    - e. Initiation of work with Kentucky.
    - f. Initiation of work with Wisconsin.
    - g. Initiation of work with West Virginia.
  - E. Further comparative studies on the effectiveness of spring and fall plowing.
  - F. Determination of costs of clean plowing as compared with ordinary plowing.

- G. Comparative cumulative effect on power requirements and crop yields of various corn crop residue treatments, and costs.
    - a. Stalks not removed. (All plowing operations followed by the regular practice in seed-bed preparation.)
      - 1. Clean plowing.
      - 2. Typical plowing.
      - 3. Plowing mutilated or chopped stalks.
      - 4. Discing only, mutilated or chopped stalks.
      - 5. Discing only, standing stalks burned with field burner.
      - 6. Plowing-under of standing stalks burned with field burner.
      - 7. Cable plowing.
      - 8. Horse plowing.
    - b. Removing all stalks (shaving and raking).
      - 1. Plowing.
      - 2. Discing only.
    - c. Other treatments.
  - H. Comparative effect on coverage and draft on soil tilth as brought about by the following three crop rotations:
    - a. Two year.
      - 1. Oats and corn.
      - 2. Oats (with sweet clover) and corn.
    - b. Three year. Oats (with alfalfa), alfalfa, and corn.
    - c. Other methods.
  - I. Studies of effect of checked and drilled corn, and flat and ridged cultivation, on coverage.
- II. Crop remnant handling - methods and costs.
- A. Stalk shaving.
    - a. Improve performance and simplify the construction of the sled-type shaver as a farmer-made machine.
    - b. Follow and improve three-row shaver cultivator attachment now devised for six makes of single-row cultivators.
    - c. Extend the development of four-row shaver attachments for other two-row cultivators.
    - d. Make field tests with shavers in other corn-growing sections, including listed corn areas.
  - B. Raking.
    - a. Continued development of the four-bar side-delivery rake; this includes consideration of power drive.
      - 1. Investigation of reel angle.
      - 2. Strengthening of frame to withstand the heavy duty.
      - 3. Design of more satisfactory tooth and method of attaching.
  - C. Stalk pick-up machine or loader.



- a. Investigate further the combination shaver, side rake, and pick-up machine.
- b. Investigate further the altered hay loader.
- c. Other types.
- D. Standing stalk mutilator or chopper.  
(This has for its purpose the destruction of borers in the stalks in hand-picked fields not to be plowed.)
- E. Baling - whole and shredded stalks.
  - a. To determine keeping properties (because of storage necessary for processing).
    - 1. With different moisture contents.
    - 2. With different conditions of storage.
  - b. Effect of different baling pressures.
    - 1. On borer mortality.
    - 2. On keeping properties.
- F. Consideration of possible combinations of some of the foregoing machines.

### III. Harvesting and processing.

- A. Devise more suitable hand cutters for cutting stalks low.
- B. Continue the development of the sled harvester.
- C. Follow the corn binder stationary knife low-cutting attachment with view to improving.
- D. Continue work on the development of a stalk chopping or mutilating attachment for a corn picker.
- E. Continue development of the field ensilage-harvester-picker.
- F. Follow commercial corn combines with a view to adapting, for use where practicable, in the corn borer area.
- G. Follow development of ensilage cutters.
- H. Follow development of husker-shredders.
- I. Continue development of the down-stalk lifting attachment.

### IV. Insecticide application. This involves the improvement of performance for corn borer control, particularly in sweet corn, of existing equipment or the development of new. (The extent of this work will depend upon the requirements of the Bureau of Entomology.)

### V. Miscellaneous.

- A. Use of corn driers - natural or artificial - to permit picking the corn possibly a couple of weeks earlier, thereby giving more time for clean-up work in the fall.
- B. Electrical - further consideration of the effects of different wave lengths of light rays in attracting moths.
- C. Other proposals.



# ANIMAL INDUSTRY







ANIMAL HUSBANDRY PHASE OF EUROPEAN CORN BORER RESEARCH PROGRAM  
FOR THE CALENDAR YEAR 1932

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A. Study of adjustments in livestock production practices made necessary by the advent of the European corn borer.

1. Further study of the influence of different borer populations upon the chemical composition of the corn plant and its several parts.
2. Determination of the influence of different borer populations upon the nutritive value of the corn plant or its parts, when used as feed for livestock.
3. The effect of control measures now being used in combating the corn borer on the economy of livestock production.
4. The effect upon the livestock enterprise and upon the quality of animal products of a change in feeding practice involving farm crops and pasture.





## BUREAU OF CHEMISTRY AND SOILS

### INSECTICIDES

1. Chemical analyses of insecticides used by the Bureau of Entomology in its various laboratory and field tests.
2. The determination of the solubility, rate of solution, crystal size, apparent density, and other physical properties of insecticides being tested by the Bureau of Entomology.
3. The synthesis of new insecticides to be tested by the Bureau of Entomology.

### UTILIZATION OF CORNSTALKS

The only means of utilization of cornstalks which at this time appear to offer a worth-while means of combating the corn borer are:

First: The mechanical pulping of the stalks for the production of alpha-cellulose, paper, wall-board, etc.

Second: A mechanical or purely chemical processing looking toward the same utilization, with possibly the conservation of evolved combustible gases as a side issue.

Third: The destructive distillation of the stalks with the recovery of various products which may have marketable value.

The first of these has been studied by this Bureau for some time, but inasmuch as several commercial concerns are now or have recently been engaged in this line, this Bureau has not paid as much attention to this phase of the work, deeming same to be progressing favorably.

In regard to the second proposed utilization, experiments are now under way at the Ames Field Station looking toward a process by chemical decomposition of cornstalks in conjunction with sewerage or packing-house wastes (as a source of nitrogen); it is impossible to present any data as yet, since this work has been organized comparatively recently. We have four men engaged at present on this problem.

In the third proposed method of utilization it is evident that economical operation requires the use of a continuous process in order to absorb any great tonnage. Experiments have been conducted for several years in studying the design and commercial operation of factory-scale equipment, in the hope of securing data as to actual costs and probable chances of success. This work has progressed to the point where it is believed that a retort of efficient design has been evolved, and experiments are now in progress on various phases of the process problems. The fact has been conclusively

demonstrated that the continuous destructive distillation of vegetable materials offers no especial difficulties, and such processes can easily become commercially feasible from an operating standpoint. There still remain the problems of securing adequate supplies of stalks for such a plant at a reasonable cost, so as to allow this process to compete with similar processes using cheaper, or more concentrated, or more easily available materials.

Since the chemical yields derivable from cornstalks are proportionately smaller, due to the light and bulky nature of the stalks, it is obvious that a large quantity must be distilled in order to secure sufficient products so as to be able to compete successfully in the sale of such products, as against other present competing processes. This work will be the subject of a report at the conclusion of the present tests.

# BUREAU *of* PLANT INDUSTRY







BUREAU OF PLANT INDUSTRY

AGRONOMIC RESEARCH, CEREAL CROPS AND DISEASES

Investigations in infested areas. (Cooperative with the Bureau of Entomology and the Ohio Agricultural Experiment Station. Calendar year 1932.)

A. Trials of standard and local varieties, and hybrids from many corn-producing States are carried on at 16 locations in Ohio.

B. Fertility and retardation experiments.

Experiments on the effect on yield and quality of crop and on infestation by the European corn borer of differences in the rate and mode of development of the plants as influenced by cultural practices and by the application of fertilizers and growth-retarding substances.

- a. Oakharbor. A comparison of fertilizer treatments at various rates in the hill and broadcast, with and without manure, on listed and level planted corn, and on corn that has been retarded in early growth by stover applications.
- b. Wooster. Experiments on the effect of applying fertilizers and retarding agencies to corn on yield and development. Comparisons of different sources of nitrogen for fertilizing corn. Studies of the relative response of different varieties and particularly different hybrids between self-fertilized lines to different levels of soil productivity.

C. Corn breeding experiments.

The corn breeding experiments will comprise the continued selection of breeding stocks and the testing of these stocks for yield and resistance to borer attack, and intensive studies of the relation of these to rate of growth and physiology of development.

a. Oakharbor.

(1) Comparing stocks for yield and for their possible resistance or tolerance to, or escapement from, borer attack under natural infestation. Detailed morphologic and physiologic studies of the different stocks.

(2) Comparing a smaller, more selected group of stocks for the same qualities as above but under artificial infestation.

b. Columbus and Wooster.

(1) Maintaining and selecting breeding stocks and comparisons of their productiveness, quality, etc. Genetic studies.

#### D. Physiologic experiments.

Studies on the rate and mode of growth of corn plants as influenced by differences in heredity and environment, and as related to yield and quality of crop and to moth preference, larval establishment, and final damage by the European corn borer. These experiments will be conducted largely near Oak Harbor but will be supplemented at Wooster and elsewhere as may be desirable. The material will consist of corn plants from the various breeding experiments and from the comparisons of different rates and dates of planting, cultural practices, fertilizer applications, etc. In general, the records of the breeding stocks, treatments, etc., and of the environment as obtained by measurements of temperature, humidity, rainfall, evaporation, wind velocity, sunshine, and soil moisture will form the causal background of variation.

The effects of this variation will be investigated through:

- a. Biochemical studies of the aromatic constituents of the leaves as possibly related to attractiveness to the corn borer moths.
- b. Determination of the growth rate during short periods.
- c. The determination of the time required to reach certain stages of development.
- d. Studies of the gross and minute structure of corn plants with special reference to variations in the vascular system, the pith and the cortex.
- e. The determination of chemical differences in plant parts with special reference to the chlorophyll content, elaboration and transformation of carbohydrates (particularly to lignification), the mineral constituents, and the carbohydrate-nitrogen relations with particular reference to their relation to the life history and development of the corn plant.

BUREAU OF PLANT INDUSTRY  
AGRONOMIC RESEARCH, FORAGE CROPS AND DISEASES

#### EUROPEAN CORN BORER RESEARCH

Two main lines of work have been established:

- (1) A study of the oil and protein content of soy beans in an attempt to select soy beans which shall be on the one hand higher in oil and protein content than the varieties we now have, and on the other, lower in oil content, in order to make them more



suitable for hogging off. (Cooperation with Ohio Experiment Station.)

- (2) Pasture Investigations. These investigations include a study of the best methods of preparing, maintaining, and utilizing a pasture in the areas in which the corn borer has already been found or in closely adjacent areas. One such field has been laid out at Beltsville, Maryland, in cooperation with the Bureau of Animal Industry and the Bureau of Dairy Industry; another in Pennsylvania, in cooperation with the Pennsylvania State College of Agriculture, and a third at Augusta, Michigan, near Battle Creek, in cooperation with the Michigan State College.

While the details of the plans under which the work is being carried on differ in some respects, the general idea at all these places is to study the most satisfactory mixtures for seeding the pasture, the best way to fertilize, the value of mowing and other treatments, and the yielding capacity as measured by increased weight of animals or yield of milk. At each station the details of the work are in charge of a competent agronomist.



# ILLINOIS







ILLINOIS PROGRAM OF RESEARCH ON THE EUROPEAN CORN BORER

ENTOMOLOGICAL RESEARCH  
1932

I - Distribution.

A - Scouting of the eastern counties of Illinois and other areas in the State which seem most likely to become infested by the European corn borer. This to be carried out by the Federal Bureau of Entomology and the Illinois State Department of Agriculture. All material found suspected of being the European corn borer will be sent in to the Federal Laboratory or to the Entomologists of the Natural History Survey for identification.

B - Through circulars, articles in the press, radio, and the Extension Department, urging individuals to send any insects suspected of being the European corn borer to Urbana for identification. In case there is any doubt regarding any material sent in, it will be promptly submitted to the entomologists of the U. S. National Museum at Washington.

II - The Effect on Infestation of Corn of Time of Planting. The Degree of Infestation of Different Varieties. Work to be carried out in cooperation with the agronomists at the Illinois plots in Ohio.

A - Complete data on the corn borer infestation in these plots will be taken, these data to include height of corn at the time of moth flight, number of eggs deposited on different plantings and varieties, larval establishment, results of infestation as they affect the vigor of the plant, the production of ears, the yield, the condition of the plant at time of harvest (whether broken or erect), the quality of the corn. These will be extended if funds permit.

B - Certain strains and varieties of corn which have shown resistance to, or tolerance of, infestation will be further tested under artificial infestation.

III - Studies of Host Plants Other than Corn. These studies to be carried on in cooperation with the Federal entomologists on the Illinois plots in Ohio.

A - As these plots are to be run on a regular three-year rotation of corn, soy beans, and wheat, with sweet clover in the wheat, special studies will be made of the degree of infestation in all crops used in the rotation; of the weeds in and about the field, or small rows of some special crops.

IV - Habits of the Corn Borer. Some incidental work along this line will be carried on in the Ohio plots. This may include experiments with light traps and bait traps.





V - Natural Enemies.

- A - Studies of the amount of parasitism of all stages of the corn borer will be carried on in the Ohio plots.
- B - Special studies are now being carried on at Urbana to determine the possibility of rearing large numbers of Trichogramma evanescens Wesm. This work will be planned along several lines to determine:
  - a - The possibility of rearing large numbers of T. evanescens in the laboratory.
  - b - The possibility of increasing the population of this egg parasite in different parts of this State, especially by liberating large numbers of adult parasites in the spring.
  - c - The effect of such liberation on the numbers of this parasite in a locality from one year to another.
  - d - The effect on the native insect fauna of the locality. This parasite is such a general feeder that increasing its numbers by artificial propagation may tend to decrease the numbers of desirable insects within a region.
- C - Propagation and dissemination of certain predatory mites which are general feeders on insect eggs and which have shown a special preference for insect eggs similar to those of the European corn borer.
- D - Continuation of the studies of parasites of our native smartweed borer and other species closely related to the European corn borer.

VI - General Studies of Insect Infestations in the Variety, Cultural, and Soil Fertility Plots in Illinois.

VII - General Studies of the Effect on Native Insects of the Cultural Practices Recommended for Corn Borer Control.

AGRONOMIC RESEARCH  
1932

I - Tests of Varieties of Corn.

- A - Grow in comparative yield tests, on cooperative plots in Ohio, approximately 20 varieties and strains of corn that have either attained prominence in Illinois or bid fair to do so. These experiments are to be conducted in cooperation with the Federal Entomologists and Dr. J. R. Holbert, of the Federal Bureau of Plant Industry.
- B - Determine the yielding ability and quality of grain produced under Illinois conditions of approximately 75 varieties of corn, many of which are early sorts. These studies are to be made at DeKalb in northern Illinois and at Urbana in central Illinois.

## II - Time of Planting Varieties of Corn.

- A - Plant a large number of varieties of corn late to determine their comparative ability to produce a good quality of grain when so handled. This is done both at DeKalb and at Urbana.

## III - Rate of Planting Corn.

- A - Plant short season varieties of corn, and one standard variety as a check, at rates ranging from 1 to 5 stalks per hill to determine the rate of planting which will give maximum yields.

## IV - Substitute Crops.

- A - Study the adaptation of different varieties of barley to the various sections of the State with the idea that this crop may prove a partial substitute for corn when the borer becomes serious.

## V.- Studies on Inbred Strains and Hybrids.

- A - Grow existing lines and hybrids of corn planted at early and late dates to determine comparative rapidity and development as indicated by dates of silking and maturity.
- B - Grow short season varieties of corn for the purpose of developing early maturing inbred strains.

## VI - The Influence of Soil Treatment Practices on the Yield and Maturity of Late-Planted Corn on New Land.

- A - During the coming season plots will be laid out on new land for the purpose of enlarging the field experiments having a bearing on corn borer control. These experiments will be planned to obtain information along three lines, viz:

1. The influence of crop rotations and soil treatment combinations on the yield and maturity of late-planted corn.
2. The influence of the rate and methods of applying fertilizers for yield and maturity of late-planted varieties.
3. The influence of crop residue used in various ways on the yield and maturity of late-planted varieties.

AGRICULTURAL ENGINEERING RESEARCH  
1932

I - Debris Coverage Studies.

- A - Comparison of plowing-under cornstalks in the fall and in the spring, as regards tendency of the stalks to be brought to the surface by weathering and operations following plowing.
- B - Study of influence on coverage of various methods of treating stalks previous to plowing, when using standard covering devices; this study to be made on various soil types.
- C - A study of the distribution and placement of debris that has been plowed under.
- D - A study of results secured by fitting new coulters, jointers, and covering wires to plows now being used by farmers.

II - Shaving, Raking, and Burning Cornstalks.

- A - Late in the fall and during the winter (fields not used to any great extent for pasture).
- B - Early in the spring before seeding of oats, barley, and spring wheat (the stalks having been used as pasture for livestock during the winter).
- C - Late in the spring, as one method of stalk treatment previous to plowing (a part of I, B, above).

III - Plowing Demonstrations--A few experimental demonstrations, before small groups, showing:

- A - Use of standard covering devices.
- B - Effect of stalk treatment previous to plowing.
- C - Correct plow adjustments and hitching.





# INDIANA





PROPOSED PLAN AND PROGRAM  
OF  
EUROPEAN CORN BORER INVESTIGATIONS  
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION  
LAFAYETTE, INDIANA

1932

ENTOMOLOGY

1. Seasonal history.  
A study of the time of occurrence of the various stages of the borer in Indiana and the effect of climate on the development.
2. Planting date.  
A study of the effect of time of planting with particular reference to populations and injury.
3. Variety.  
A study of the comparative populations and tolerance of varieties and the factors determining any differences which might occur. (In cooperation with the Departments of Agronomy and Botany.)
4. Insecticides.  
A study of the comparative efficiency of some insecticides and the timing and number of applications required.
5. Rate of planting.  
A comparative study of different rates of planting with reference to population and injury and the factors involved in any differences which might occur.
6. Fertilizer.  
A study of the effects of fertilization on borer population with special reference to the use of fertilizers in late planting.

AGRICULTURAL ENGINEERING, 1931-32

A - Soil working.

To find relative effectiveness of covering cornstalks, stubble, and other crop remnants by:

- 1 - Different widths of plows.
  - a - As effected by depth of plowing.
  - b - Plow attachments.





- (1) - Shields which will cause the stalks to be placed in the bottom of the furrow.
  - (2) - Different types of coulters and jointers.
- 2 - To test the above as effected by previous treatment as discing (single-double), rolling, cultipacking, etc.
- B - Crop remnant cleaning.
- 1 - Detaching stalks.
    - a - Poling.
    - b - Shaving.
      - (1) Sled shavers.
      - (2) Cultivator shavers.
  - 2 - Collecting stalks.
    - a - Dump rakes with attachments and changes.
    - b - Special side-delivery rakes.
- C - Field machinery.
- 1 - To study the possibilities of shaving, collecting, and cutting up cornstalks fine enough to kill the contained corn borers. This method is designed to eliminate the necessity of plowing before seeding small grain in cornstalks left by mechanical or hand picking.
  - 2 - To obtain cost data on corn production under Federal Corn Borer Clean-Up Regulations, using a general purpose tractor as the motive power for all operations.

#### AGRONOMY

- A - Variety and date of planting tests. At several locations about 30 varieties planted at four dates at two-week intervals beginning at the normal date. These varieties range from very early to late.
- 1 - Determine comparative yields and quality of grain of the varieties and their adaptability to late planting.
  - 2 - Study characters of the varieties which may render them resistant or tolerant to attack by the corn borer.
  - 3 - Study infestation and damage from corn borer attack.  
(In cooperation with the Department of Entomology.)
- B - Rate of planting tests. Using a standard and an early variety at each location and various distances between hills and various numbers of stalks per hill.

- 1 - Determine the optimum rate of planting for both early and standard varieties, considering both yield and size of ears.
  - 2 - Learn the effect of rate of planting on infestation and damage from the corn borer. (In cooperation with the Department of Entomology.)
- C - Fertilizer tests. Plant an early variety late and fertilize with (a) different formulas, (b) different amounts, and (c) at different times.
- 1 - Study the effects on yield and quality of grain.
  - 2 - Note the effect on infestation and damage from the corn borer. (In cooperation with the Department of Entomology.)
- D - Disposal of corn stalks. Disposal of corn stalks in various ways.
- 1 - Find the effects on the yields and quality of the crops in the rotation under the various methods of disposal.

#### FARM MANAGEMENT

A cooperative project with the U. S. Bureau of Agricultural Economics, entitled "A Study of Adjustments on Farm Organization and Management and of the Complete Utilization of the Corn Crop as Related to the Corn Borer." Object of the project, to determine:

- 1 - The most successful systems of farm organization and management, and the utilization of the entire corn crop as an effective means of controlling the European corn borer.
- 2 - The extent to which different methods of corn stalk utilization and disposal are now being practiced under different conditions.
- 3 - Changes that should be made in crop rotations, livestock combinations, type of equipment, and farm practices, in order to better utilize corn stalks in ways that will give greater financial returns, economically conserve soil fertility, and most effectively control the European corn borer.

# MICHIGAN







MICHIGAN  
EUROPEAN CORN BORER RESEARCH PROGRAM

ENTOMOLOGY

Life History:

Egg:

Deposition.

Hatching.

Larva:

Development.

Survival.

Migration.

Infestation Studies.

Corn and stubble.

Variety tests.

Date, rate, and space planting.

Date of harvest.

Fertilizer, topping.

Parasites and Predators.

Miscellaneous.

How and why does the corn plant resist European corn borer?

AGRICULTURAL ENGINEERING

We have done and are doing some work on the following projects in connection with the corn borer in agricultural engineering. Funds have not been permitted us to do any extensive work.

1. Plowing.
2. Hand methods of control.
3. Low cutting in cooperation with the Corn Borer Office, Toledo.
4. Use of "T" rail and leveling devices.

## AGRONOMY

1. Testing, for borer resistance, inbreds from crosses of native corn varieties with Maize Amargo, a borer-resistant strain. These inbreds will be tested in the  $F_3$ ,  $F_4$ ,  $F_5$ , and  $F_6$  generations.

2. Borer resistance and yield tests will be made on synthetic corn lines resulting from combinations of a large number of inbred strains of native corn crossed with Maize Amargo, which have shown resistance to the borer in former tests.

3. Inbreeding of backcrosses which have been made during 1931 between Maize Amargo and native corn crosses and native Michigan corn.

4. Testing for borer resistance and further inbreeding sweet corn inbreds resulting from crosses made between sweet corn varieties and Maize Amargo.

5. Study of plant characters, such as leaf area, breaking strength of stalk, height of plants during moth flight, etc., to determine their possible relation, if any, to corn borer resistance.

## FARM MANAGEMENT

1. A study of the changes in farming practices and farm organization in southeastern Michigan on account of the European corn borer. In 1927, in four different areas, 250 farmers were visited and information was obtained in regard to changes in corn acreages and numbers of livestock; in regard to changes in farm practices in preparing corn land for succeeding crops; and extra time required in the clean-up operations. This project will undoubtedly be carried on again this year.

2. Farm organization studies in the corn borer area are being arranged for the coming year. These studies to serve as a guide in determining the most successful kind of farm organization in these areas.

# NEW HAMPSHIRE







NEW HAMPSHIRE  
EUROPEAN CORN BORER RESEARCH PROGRAM  
ENTOMOLOGY

Life history studies.

Relative preponderance and mortality of the one-generation and the  
two-generation phases under New Hampshire conditions.

Parasite studies.

Host plant studies.



# NEW YORK







## CORN BORER INVESTIGATIONS IN NEW YORK

Agricultural Experiment Station, Geneva, N. Y.

1. A study of the life history and occurrence of the corn borer in western New York with special reference to the influence of weather conditions on the abundance of the insect.
2. The effect of the time of planting on the rate of infestation of several varieties of sweet corn in different areas in western New York. Determination of the influence of various factors, such as height, development of the corn, and soil conditions on the amount of infestation in sweet corn.
3. The study of various materials to be used as insecticides against the young caterpillars, especially with reference to their toxicity to the insect and the tolerance of the corn plant. Summer oil emulsion and arsenate of lead will receive major attention since this combination has been shown the most promising during the past few seasons. Attention will be given to the time of applications in relation to oviposition and hatching of the larvae and the number of applications necessary to control the insect.
4. A survey of the amount of infestation in the Eden Valley market garden area in Erie County will be continued. In this section farm operations concerning the disposal of sweet-corn stalks and stubble are such that they should throw light on the value of clean-up measures on the control of the insect.
5. List all plants sought by the larvae for food and shelter.
6. Systematic collection of corn borer parasites and determination of relative importance.



# OHIO







THE EUROPEAN CORN BORER PROGRAM

1932

Departments of Entomology and Agronomy  
of  
The Ohio Agricultural Experiment Station

A. The corn borer.

1. Ecology. Further analysis of the environment.  
Particular studies in northwestern Ohio.
2. Physiology. Studies on the relation of first and second instar larvae to corn development. Causes of varietal resistance and tolerance.

B. The corn plant.

1. Physiological, biochemical, and morphological investigations.
2. Corn development with reference to variety, date of planting, etc.
3. Corn breeding. The evaluation of inbred lines as to resistance and tolerance.



# PENNSYLVANIA







CORN BORER RESEARCH - PENNSYLVANIA STATE COLLEGE - 1932

ENTOMOLOGY

1. Life history and seasonal occurrence in central Pennsylvania.

(Fifth year.)

2. Mechanical methods of control.

(a) The plowing of whole stalks.

(b) Low-cutting devices.

In cooperation with the Department of Agricultural Engineering, the Farms Department, and the Bureau of Agricultural Engineering, U. S. Department of Agriculture.

Further work in insecticidal control will await increase in natural infestation in Pennsylvania.



# JOINT COMMITTEE ON THE EUROPEAN CORN BORER



APPOINTED BY  
AMERICAN FARM ECONOMIC  
ASSOCIATION

AMERICAN ASSOCIATION  
OF ECONOMIC ENTOMOLOGISTS

AMERICAN SOCIETY OF  
AGRONOMY

AMERICAN SOCIETY OF  
AGRICULTURAL ENGINEERS

AND  
AMERICAN SOCIETY OF  
ANIMAL PRODUCTION





REPORT OF THE JOINT COMMITTEE ON EUROPEAN CORN BORER

Toledo, Ohio, September 30, 1931.

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The natural spread and increase of the European corn borer, which was retarded by the abnormal season of 1930, was resumed in 1931. The intensity of infestation in 1931 was about two and a half times that of 1930 and more than twice that of 1929. Although the past season cannot be regarded as having been exceptionally favorable for the corn borer, some of the serious infestations recognized as possible in the 1930 report of this committee actually occurred. As a result, there is a much larger number of larvae at present than in the fall of 1930, with a consequently greater danger for 1932. The increase in borer population was particularly heavy (1) in northwestern Ohio, south of the former center of infestation along Lake Erie, and (2) in the important sweet corn area along the southern and eastern shores of Lake Ontario in New York.

The present infested area includes all of the corn-growing areas in Canada, excepting the western provinces; also 220,000 square miles in the United States, including the southern two-thirds of New England, northern part of New Jersey, all of New York, three-fourths of Pennsylvania, the panhandle of West Virginia, practically all of Ohio, the northeastern half of Indiana, and nearly all of the agricultural portion of Michigan. In the area east of the Connecticut River in Connecticut, Massachusetts, and States north, in that territory in Connecticut west of the river adjacent to Long Island Sound, and in restricted localities in New Jersey, the two-brooded form occurs, while in all other infested sections of the United States and all infested areas in Canada, excepting Nova Scotia and New Brunswick, only the one-brooded form occurs. Small isolated infestations occurred in eastern Wisconsin, Kentucky, and extreme southern Indiana.

The increase in spread and infestation in 1931 further demonstrates that seasons of increase and decrease in borer abundance will occur as with other crop pests. Temporary checks to the corn borer in individual seasons, such as that in 1930, must not be interpreted as minimizing the seriousness of the insect as a destructive agency.

The large increase in borer population in 1931 emphasizes that the European corn borer is one of the most potentially destructive crop pests ever introduced into America. This fact calls for the continued cooperation of the farmer, the scientist, the educator, and all State and Federal administrative officials.

The joint committee of entomologists, agronomists, agricultural engineers, agricultural economists, and animal husbandmen commends the efforts of all farmers practicing recommended control measures and of those engaged in the research, regulatory, and educational activities.

The committee recognizes the necessity for the continuation of the research, educational, and quarantine programs of the State and Federal Governments and earnestly recommends the appropriation of the funds needed to maintain, and if necessary, to expand them as suggested later in this report. The committee recommends this support only after due consideration of the absolute necessity of holding current governmental expenditures to a minimum.

After careful investigation of the regulatory, research, and educational activities, the committee suggests and recommends:

1. Since the enforcement of quarantine regulations in the United States had undoubtedly been instrumental in preventing long-distance spread of the insect in the past, that this activity of the Federal Governments of the United States and Canada, as well as the State and Provincial governments, be supported and encouraged by all agencies and individuals interested in the welfare of American Agriculture. These activities should include: (a) thorough scouting, (b) careful clean-up of isolated infested areas, and (c) maintenance of quarantines.
2. That the extension agencies of the Federal governments of the United States and Canada and of the State and Provincial agricultural colleges strengthen and coordinate their programs of education relating to the corn borer, extending these to conform with the spread and abundance of the insect and with the increased knowledge gained through research.
3. The entomological investigations now in progress should be continued. The following studies on which material progress already has been made, should be especially stressed: (a) the expedition of parasite introductions and the development of artificial media for mass production of parasites, (b) the development of effective insecticides and their efficient application, (c) evaluation of the effect of environmental factors on the insect's activity.
4. While the development of immune varieties seems unlikely at this time, experiments point clearly to the probable development of high yielding resistant and tolerant varieties of corn which should be an important factor in control. To promote the development of such varieties, the corn breeding programs of the State and Federal governments should be continued and strengthened.
5. Inasmuch as control of the borer, as yet, depends largely upon mechanical means in the hands of growers, it is recommended that research and development work along mechanical lines by the agricultural engineers be continued and be strongly supported by the Federal Government and by the States, with a sincere effort being made to coordinate such activities through the Bureau of Agricultural Engineering.



In such work it is recommended that attention should be directed first toward machine types now common on farms, in view of the fact that agriculture cannot easily avail itself of new types of equipment primarily for control until it has used to the best possible advantage the equipment now on farms.

Attention is drawn to the fact that considerable development work has been accomplished and now awaits adoption by the various extension forces and by the manufacturers of farm equipment. It is recommended that the extension forces bear in mind that the better use of equipment now on farms is to be fostered.

The manufacturers are to be commended for their interest and loyal support in corn borer work to date, and, in spite of the readjustment period, it is hoped that they will continue rapidly to convert development accomplishments into the commercial channels, so that the growers--who must carry the burden of control--will not be handicapped by the latest practical mechanical devices not being available to the public.

6. Since the corn borer control practices developed and proposed may change the organization and income of the farm, it is important that the relation of these practices to the entire farm business be determined and recommendations made for specific conditions. Proposals including changes in cropping systems, complete utilization of corn, substitute crops, changes in corn acreages, and labor and equipment costs should be worked out in line with the objective of maximum returns from farming.
7. Continued and further studies should be made on the influence of different borer populations upon; (a) feeding value of corn and the corn plant in different forms, (b) upon the yield of feed nutrients per acre, (c) comparative feeding value due to different methods of harvesting and preparing crop, (d) use and feeding value of substitute crops and (e) the influence of the corn borer and resultant control measures upon the cost of production and the quality of livestock products.

Respectfully submitted,

Committees

American Association of Economic Entomologists

G. A. Dean  
L. Caesar

D. J. Caffrey  
T. J. Headlee

J. J. Davis

American Society of Agronomy

L. E. Call	J. F. Cox
W. L. Burlison	R. M. Salter
F. D. Richey	

American Society of Agricultural Engineers

C. O. Reed	A. L. Young
W. C. Harrington	R. B. Gray
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American Society of Animal Production

E. W. Sheets	Paul Gerlaugh
F. G. King	G. A. Brown
F. B. Morrison	



REPORT OF THE COMMITTEE ON ALLOCATION OF THE  
EUROPEAN CORN BORER RESEARCH WORK  
FOR 1931

The Committee on Allocation of the European corn borer research work met at Toledo, Ohio, September 29 and 30, 1931. A full membership of the committee was present with the exception of Dean L. E. Call, E. B. Hill, and E. W. Sheets. Dean Call was represented, however, by Dr. W. L. Burlison, Acting Chairman for the Committee of the American Society of Agronomy, and E. W. Sheets by E. W. McComas of the American Society of Animal Production. The committee met with and assisted in preparing the report of the Joint Corn Borer Research Committees of the American Association of Economic Entomologists, American Society of Agronomy, American Society of Agricultural Engineers, and American Society of Animal Production, and accompanied these societies on a one-day tour of the research and experimental farms and plots being conducted by the Federal Bureau of Entomology at Monclova, Ohio, and the Ohio research farm at Oak Harbor, and also examined a number of fields of corn in Lucas, Wood, Sandusky, and Ottawa Counties, Ohio.

After carefully going over various projects now being carried on by the Corn Borer Research organizations of the Bureau of Entomology and of several States engaged in this work, it is the opinion of the committee that at the present time there is no undesirable duplication of work. While some duplication is taking place, it is along lines where such duplication is desirable and should be continued.

Very appreciable progress in the work has been made, especially along the lines of mechanical control, and certain results of this research work have now developed to the point where definite recommendations regarding their application on farms can be made and where it seems desirable that these results should be made as generally available as possible to farmers in the infested areas. Commendable progress has also been made in the testing of corn varieties for resistance and tolerance to the borer and the development thru plant breeding of tolerant or resistant strains of corn. Considerable progress has been made in the farm management studies.

It is regretted that it has been found necessary to discontinue certain lines of Federal research work, although the necessity for saving in this way is recognized by the committee.

It was the unanimous opinion of the committee that a complete program of the research work now being conducted by the Federal, State, and Dominion agencies be compiled during the coming winter as has been done for several years and that copies of such research program be made available to those interested in corn borer research.



It was also the opinion of the committee that under present conditions it would not be advisable to call a meeting of the research workers in Washington during the coming winter because of the expense involved by such a meeting, although past meetings have been helpful and are desirable when they can be conveniently held.

Respectfully submitted,

G. A. Dean, Chairman  
C. O. Reed  
L. E. Call  
H. G. Crawford  
D. J. Caffrey  
J. S. Houser  
W. P. Flint  
R. B. Gray  
E. W. Sheets  
E. B. Hill

Committee







